Comments on the draft proposal to amend the Code with respect to trace fossils (Proposal, see BZN **60**: 141–142, 215–216)

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In the recent proposal to clarify the meaning of the term ichnotaxon, Bertling et al. (BZN **60**: 141–142) suggested that the Glossary definition of 'work of an animal' should be emended. To supplement the proposed definition of trace fossil, the draft included clearly worded lists of structures that qualify as trace fossils and otherwise. In the proposal, fossil cocoons, pupal cases, plant galls and spider webs are considered to be animal products instead of true trace fossils. However, a vigorous general discussion in the ichnologic community in July and August 2003 (Skolithos, 2003) resulted in a consensus that these terms include some structures that qualify as trace fossils, suggesting the need to refine the wording further. Such refinement is proposed herein to reduce ambiguity between trace and body fossils, delineating a sharper boundary around the ichnological realm.

Cocoon is used in the invertebrate literature with different meanings. Many insect cocoons are structures built of silk and different amounts of other materials to oviposit, or protect larvae and pupae (e.g. Chapman, 1982). *Pallichnus* Retallack, 1984, *Fictovichnus* Johnston et al., 1996, *Rebuffoichnus* Roselli, 1939, and *Teisseirei* Roselli, 1985 are available ichnotaxa for pupal chambers (or cocoons or pupal cases) found in paleosols (Genise et al., 2002). Fossil wasp cocoons have also been recorded but not named (e.g. Bown et al., 1997). Eleven ichnogenera are attributed to trichopteran (caddisfly) cases made with silk and various coarse materials in aquatic environments (e.g. Sukatcheva, 1982, 1999). The ichnotaxonomy of caddisfly cases is well developed. The first ichnogenus was erected by Bosc (1805) and, at present, this is one of the few ichnotaxonomic arrangements that utilizes ichnosubgenera (Sukatcheva, 1982). These cocoons involve behaviour (weaving) and modification of substrate (silk and other materials), thus qualifying as true trace fossils.

In contrast, the so-called 'cocoons' of clitellates (e.g. Manum et al., 1991) and puparia of dipterans (e.g. Chapman, 1982) are just secretions and tanned larval cuticles, respectively; they involve neither behaviour nor modification of substrate. These more likely qualify as body fossils. Thus, we consider all kinds of constructed cocoons (e.g. woven cocoons, caddisfly cases) as trace fossils, whereas simply secreted cocoon-like structures and larval cuticles, such as clitellate 'cocoons' and dipteran puparia, are body fossils.

Similarly, the proposal ruled out spider webs as traces because they were considered, along with eggs and pearls, as secretions (Bertling et al., 2003). However, in spider webs and egg cocoons, the producer weaves the silk in a second step into a construction (i.e. a trace; e.g. Foelix, 1982). Fossil silk threads from spider webs are exceedingly rare in the fossil record (Poinar, 1998); the oldest examples have recently been reported from Early Cretaceous Lebanese amber (Zschokke, 2003). Cocoons are also sometimes preserved in amber (Poinar, 1998). One ichnogenus of caddisfly cases, *Secrindusia*, is basically composed of silk with few if any clastic particles (Sukatcheva, 1999). Indeed, the morphology of fossil trichopteran cases shows a

continuum from structures composed almost entirely of silk to those in which silk is only sparingly used to cement other materials. It is impossible to demark a boundary between traces and non-traces based on the amount of silk incorporated within a structure. Regarding the proposed definition of trace fossil, in constructed webs, nets and cocoons, silk is considered to be the substrate that is modified by the producer.

In addition, the substrate to which these silk structures are attached may also be modified. Trichopteran silk nets and cases may play an important role in the deposition of travertine (Drysdale, 1999; Leggitt & Loewen, 2002). Silky webs, nets and cocoons are true traces, not comparable to eggshells or pearls, which are un-reworked secretions. Nor are they comparable with agglutinated foraminiferan tests, which incorporate sand grains actively on the cell wall. These tests may fully match the producer morphology, and as such they are considered body fossils.

Plant galls may be initiated by viruses, fungi, other plants and invertebrates, especially arthropods. Accordingly, diverse kinds of galls exist that may involve the abnormal production of organs or tissues, which in turn may be patternless or show a repeated size and shape (Scott et al., 1992). Ichnologically, it is important to consider that in insect-made galls, the larva grows by feeding from the plant tissues, pupates and emerges as an adult. In doing so, it produces a boring, pellets, a pupal chamber and an exit hole, all of them true traces that have been recorded in fossil leaves and stems (e.g. Scott et al., 1992; Labandeira & Phillips, 1996). In other cases, galls may preserve only the plant reaction tissue and as such may not qualify as trace fossils. The oviposition, plus the larval boring, pellets, pupation chamber and exit hole together make up a composite trace fossil inside the reaction tissue, similar to other traces in leaves, but with disproportionate development of reaction tissue. Besides, all recognized traces of phytophagy, not just galls, produce reaction tissue (Scott et al., 1992; Labandeira, 1998). It is impossible to rule out traces involved in galls, if only because they are surrounded by particularly developed reaction tissues. Moreover, the gall inducer often directly controls the growth, shape and consistency of the reaction tissue (even by DNA transfer). It is difficult in this case to decide where the behaviour of the gall inducer starts to be replaced by mere 'secretion' by the plant. Hence, the term gall should be discarded because it is ichnologically ambiguous, whereas more properly defined plant reaction tissue may be included as a clear example of a structure that does not qualify as a trace fossil.

In conclusion, the proposal by Bertling et al. (2003) is affirmed though slightly modified. The Code must be clear, and thus has to define ichnotaxon accurately. We propose to define an ichnotaxon as the name of a trace fossil (including burrows, borings and etchings, tracks and trackways, coprolites, gastroliths, regurgitaliths, nests, woven cocoons, spider webs, leaf mines, some type of galls, bite and gnaw structures).

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Bertling et al. (BZN **60**: 141–142) have proposed various changes to a new edition of the Code, which were commented on by Tubbs (BZN **60**: 215–216). His comments show that major arguments obviously have not been put in a way fully comprehensible for the non-ichnologist. Among other things, he states it is not the case 'that the Code draws a distinction between fossilized tracks and other "works" such as galls, coprolites and nests' (para. 7). This necessitates two replies. In a separate note,

Genise et al. (see (1) above) explain why some kinds of galls and cocoons must not be considered traces or trace fossils, respectively. This should prohibit apodictic declarations such as 'names based on fossilized galls, cocoons, etc. are ichnotaxa' (see BZN 60: 215–216). And in the current comment, we address other arguments raised by Tubbs that need further consideration.

A crucial issue is the relationship of the terms 'work of an animal', 'ichnotaxon' and 'trace fossil'. Tubbs admits that 'confusion perhaps arises from the Glossary' (para. 3) but nonetheless argues in favour of retaining the wording of the Code and creates the impression that the current wording covers all ichnological nomenclatural needs. This is not the case. The Bertling et al. proposal originated from the need felt by ichnologists to revise the obsolete definitions in the Code that have been carried forward from earlier editions. Tubbs argues that the revised definitions differ from those given in the Code, which is true and intended. This statement is his main argument for rejecting the proposal. As biologists and geologists, we fully understand the difficulty that non-specialists have in dealing with names that are based ultimately on living behavior rather than genetic material. However, as specialists who have debated these topics for several years, we consider that we have now defined the objects of our study in the most parsimonious way.

Further on, Tubbs states that 'all these fossils [galls, cocoons, etc.] are commonly called trace fossils' (para. 2). Apart from the fact that very few papers have ever been published on fossil galls and cocoons, introducing 'common' usage of specialist terms into a legislative work that aims at maximum clarity is counterproductive. In addition, some structures that are commonly considered the work of animals (and other organisms) are not considered trace fossils, e.g. soils and biologically induced or destroyed bedding. Against this background, Bertling et al. tried to clarify the terms 'work of an animal', 'ichnotaxon' and 'trace fossil' precisely because their Code definitions are obsolete. The seemingly most commonly understandable term, 'work of an animal', is the most ambiguous, especially as it has hardly been used in the last few decades of ichnological literature. Based on the perception that the Code should not contain ambiguous expressions, Bertling et al. favoured eliminating the obsolete and unscientific, thus unnecessary term, 'work of an animal' from the Code. Tubbs cites the proposal in a misleading way in stating that 'Bertling et al. propose . . . to define 'work of an animal' as trace fossils . . . as well as secretions such as eggs . . .', as it was not the aim of the proposal to define the term 'work of an animal' but to explain its ambiguity. Tubbs's comment also shows why terms of common usage should be avoided. Trace fossils and their names (ichnotaxa), on the other hand, are well defined, even though some specialists in marginal fields (e.g., fossil eggs) have idiosyncratic ideas about ichnology. It would be of little help therefore to add a Glossary entry 'trace fossil', as offered by Tubbs (para. 7) without deleting 'work of an animal' from the text.

A different issue is the question whether the Code covers ichnotaxa of non-animal origin. In the eyes of the ichnological community, it was a welcome sign of progress in the current edition of the Code to see 'animals' in Article 1.2.1 changed to 'organisms'. How else should one deal with ichnotaxa whose producers cannot be assigned to a kingdom? Dozens of ichnotaxa of questionable producer assignment have been erected under the provisions of the Code and are used by active and respected ichnologists (e.g., Radtke, 1991; Vogel et al., 2000). These trace fossils may

have been produced by protists, fungi, chlorophytes or cyanobacteria, i.e. they may be of animal origin or not. Tubbs denies this situation encountered in daily ichnological work in stating 'if the agent is known not be an animal the Code does not apply'. Following this personal interpretation of Article 1.2.1, an ichnotaxon would be subject to the Code as long as its producer would be unknown; it would fall outside the provisions of the Code as soon as the non-animal origin of the trace fossil could be demonstrated. This argument can be considered unrealistic because the producer can never be identified with certainty. There will always be a chance that extinct or unknown organisms have produced structures that look like those nowadays resulting from different life activities.

Even more dramatic is Tubbs's misconception that 'fossilized works of animals' and 'trace fossils' are synonymous (para. 3). This statement, which is demonstrably erroneous, is a circular argument based on the current wording of the Code. There are many more trace fossils than those of animal origin but neither the botanical nor the bacterial Code contains provisions for ichnotaxa. This means that an ichnotaxon going back to an unknown or non-animal producer currently has no 'legal' standing. For these reasons, we adhere to our opinion that any trace fossils irrespective of their origin should be covered by the zoological Code.

Some other points are uncontested. We understand the reasoning provided by Tubbs not to revoke Article 1.3.6 as originally proposed. Also, ichnologists will gladly accept the clarification that ichnofamilies require typification and that ichnofamilies do not compete with biotaxa.

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